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**Status Report on
SCIENTIFIC AND TECHNICAL
INFORMATION
in THE FEDERAL GOVERNMENT**

DC

JUNE 18, 1963

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of the

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

United States of America

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FOREWORD

With science and technology emerging as important instruments of policy, the manner in which this nation fosters creative research and development and provides for its effective management is one of the major issues for executive and legislative decisions today. Science and technology not only contribute very significantly to our military security, but also manifest a profound influence on the vigor of our domestic economy, and on the improvement of the health of the nation. While the fruits of science and technology have been significant, they also have imposed an unprecedented demand on our nation's resources. The broad range of opportunities has resulted in the present great competition for these funds and, possibly even more important, for scarce manpower as well.

Because federal funding for research and development now accounts for approximately 65% of the nation's research and development effort, and because manpower resources are inevitably in scarce supply, increasing attention must be given not only to what research and development programs are undertaken but also to how these programs are conducted. Therefore, to assure a minimum of both gaps and redundancies, and to make optimum use of research resources, all echelons of R&D management require information about research.

The communication of scientific results is thus critical to the achievement of high quality scientific endeavor and prompt and efficient conversion of results to technology. The report which follows is concerned with the nature of this communication problem and includes the Executive Branch view toward the policies, plans, and practices related to achieving an adequate flow of needed information.

Those who are generating new data and information seek always to work at the frontiers of knowledge, and thus seek to maintain a continuing awareness of achievement by others. Moreover, where so many of our national goals now heavily involve science and technology, the pace of their accomplishment may depend upon the rate and effectiveness by which scientific results are communicated to the engineering community and to those who make policy. To increase the swiftness by which data are communicated is a necessary, but by no means a sufficient condition for a contemporary information system. As the President's Science Advisory Committee has so clearly stated, the effective switching of specialized information is the important element. This switching has the important implication that no single document or spoken word can be all things to all people, that information must be rewritten or restated for each type of a variety of users. We thus recognize that there are different classes of contributors of information and different classes of users: i.e., research scientists, design engineers, program administrators, and policy staff.

As science and technology have grown so has the volume of communication and the complexity of communication channels. Existing techniques for communication have been severely strained. Moreover, many of our social customs, such as the use of published papers as a measure of professional attainment, increase the volume of information generated and reduce the effectiveness of the communication channels. Oral communication, being more flexible and benefiting by modern advances in voice communication and transportation, has been given a proportionately greater burden of scientific and technical communications. The flow of the scientific literature has been experiencing greater stresses as a medium of communication.

Science has outgrown its organization along well delineated disciplines of the past. The lines of demarcation are now much hazier, and new disciplines have appeared at the interfaces of the older disciplines. Whereas in the past, scientific communications remained within each discipline, there are now many new demands for information to be translated and extracted for use by other disciplines and by the technologies. These new and different burdens are being placed upon the scientists, engineers, and upon the documentalists to insure the viability of communication systems for research and development.

The federal government has assumed an increasingly large share of the support of scientific and technological research in this country. Its policies and practices thus critically influence the health and effectiveness of the nation's research effort; and the widespread expressions of concern about the government's responsibilities in the field of science information are symptomatic of this new relationship. The federal government's interest in scientific and technical information has grown during the past several years in response to the increasing difficulty of scientific communication. In 1958 a panel of the President's Science Advisory Committee examined science information activities. The Senate Government Operations Committee and its Subcommittee on Reorganization and International Organizations, have intensively examined the federal role and the federal programs. During 1962 a second panel of PSAC undertook yet a further examination of the nature of information problems, and their findings were set forth in a report released by the President in January 1963. The work of this panel was significantly assisted by a full-time task force which studied the organization aspects of scientific communications of the federal agencies.

Over the past 15 years, a number of specific legislative and executive actions have been taken to strengthen the federal science information activities: The Office of Technical Services was established in the Department of Commerce to disseminate government reports; the Office of Science Information Service was established in the National Science Foundation to promote government-wide scientific information processes and to improve the understanding of these processes; the Federal Council for Science and Technology, and more recently the Office of Science and Technology, were established to assist the President in formulating government-wide policies that would better assure coherence and consistency in science information activities of the various agencies.

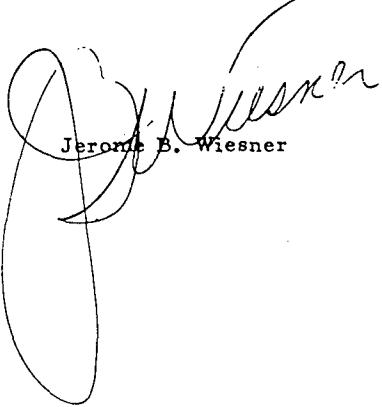
The importance of an effective science information system is, in fact, reflected in the review and the continuing study which this problem is receiving within the Executive Office of the President. Because scientific information and the processes of communication are an intrinsic part of research and development, the Executive Branch recognizes that its sponsorship of research carries a collateral obligation to assure that fruits of such research are made part of the common pool of knowledge. The Executive Branch recognizes the essentiality of good communications to the prudent management of the government's R&D programs. The federal government also recognizes its obligation to make sure that the results from research are equally accessible to individual scientists and engineers, to industrial enterprises, and to other non-government institutions. While the problems of internal communications in the government are themselves formidable, the problems of dealing with the scientific and technical communication controlled and operated by private institutions are even more difficult. For one thing, the danger in upsetting the competitive balances of private and professional information services and publications by any of the several activities of the government is acknowledged. The Executive Branch is aware of how quickly its influence is felt in the private economy.

The motivation from the point of view of the executive is not simply one of administrative tidiness. There is a clear recognition that research conducted for the solution of one problem is frequently employed in unexpected ways for the solution of other problems. In the process of conducting federally sponsored research in the interest of defense or in the exploration of outer space, we develop an enormous reservoir of scientific information. And it is from this reservoir that we have grown to expect important contributions to be made to our civilian technology, to that part of our economy which must compete in the world market with superior goods and services.

Another important development in the Executive Branch is the recognition that many of our important programs necessarily involve the participation of a number of different federal agencies--each having a special part to play in carrying out its statutory mission. Our experience has confirmed for us that in science, as in other activities, it is wise indeed for the structure of government to reflect the pluralistic aims and interests of our society. Nevertheless, it is essential that these programs advance with a minimum of undesirable duplication and with a maximum of cross-agency stimulation. Thus, information must be exchanged between agencies about research in prospect so that each may plan in the full knowledge of others' intentions. Providing the necessary management tools to facilitate effective communication is, from our point of view, an essential part of the information process. Scientific intelligence, i.e., information about who is doing what, where, and with what funds, can be used by each agency and by the Executive Office,

and by the Congress, to map out the current research and development effort of the whole government, and in some cases of the whole nation. It can be employed to determine where emphasis is currently being placed, where gaps or imbalances exist, how available talent is being employed, and whether appropriations and priorities are keyed to the national objectives.

With this perspective, the federal government and its constituent agencies are developing principles for an effective science information system and an articulation between components that will focus activities for a common purpose. In this regard, we have adopted the view that it is both unwise and impracticable to concentrate all of the science information activities in a single agency. Steps have been taken, however, to identify a focal point of responsibility in each agency for the development of plans and programs within the agency consistent with the overall objectives. A second step has been taken to coordinate elements of the government-wide system through a Committee on Scientific Information of the Federal Council for Science and Technology. Also, in recognition of the interplay between the federal and non-federal entities, the Committee on Scientific Information and the Office of Science and Technology will continue to look to outside consultants so that problems involving private institutions and individuals will gain careful consideration in the development of federal policies. Finally, a number of important policy steps have been taken regarding the use of science information both as an element of research and development and as a management tool. These are summarized in the early part of the report which follows. Also, as a step toward improving this federal system, it has been necessary to take stock of the various science information activities in which the federal agencies are engaged. This report, prepared as a working paper for the Federal Council, represents such an inventory and is being made available to provide a better understanding within and without the government of the problems of scientific and technical communication and remedial actions being undertaken.



Jerome B. Wiesner

SUMMARY

This report summarizes the recent advances and the present status of Federal efforts to improve the handling of scientific and technical information. Federal agencies* have given increased attention and support to their activities in the field of scientific and technical information in recent months. Important improvements have been made or are under way both within and outside Government as the agencies have moved forward to develop an effective national program. The primary goal is to increase the effectiveness of R&D management in the Federal Government. A corollary goal is to make readily available to all U. S. scientists and engineers the world's current and past output of significant scientific information.

Within the Federal establishment, the significant actions in the scientific and technical information program may be summarized as follows:

Each Federal Department or Agency with a significant scientific and technical information activity has established a focal point of responsibility for such activity. The Chart attached indicates the individuals assigned in each case.

The Federal Department or Agency focal points have been constituted as the Committee on Scientific Information of the President's Federal Council for Science and Technology. As such, they are a mechanism for inter-agency coordination and development of Government-wide standards and compatibility between systems, with the objective of developing an articulated but decentralized Federal information system.

With the advice and concurrence of the Federal Council, the COSI-sponsored proposal for a National Standard Reference Data System has been adopted as a matter of Federal policy. The System will provide scientists and engineers with critically evaluated numerical data in the physical and engineering sciences necessary for the research and development process. The National Bureau of Standards under the Department of Commerce is now establishing the System.

The Science Information Exchange is extending its coverage of information on research tasks in progress to include the physical sciences. At the request of COSI and with the endorsement of the Federal Council, the Director, Office of Science and Technology has recommended that fiscal and managerial responsibility for the SIE be transferred to the National Science Foundation. The action was taken to eliminate budgetary and administrative problems that have slowed progress in this area. Steps necessary to make the change are now in progress.

A report, entitled "Science, Government, and Information," has been published by the President's Science Advisory Committee, Panel on Science Information. This report sets in perspective the national importance of the communication of science and technology and provides a basis for improving the national scientific information program.

The COSI, representing the major report-producing agencies in the Federal government, is working toward the adoption of several measures to speed up and simplify the inter-agency processing of reports. For example, AEC and NASA have already agreed on a standard photographic form for document storage, with other agencies to follow suit as soon as equipment problems are resolved. COSI is also working toward the development of interchangeable indexing procedures.

The Library of Congress and the National Science Foundation have established and are operating a National Referral Center for Science and Technology. Its function is to direct any scientist or research organization to the source of information, including the large number of specialized information centers, most appropriate to

*This Status Report is the summation of extensive individual agency reports, the originals of which are in the files of the Office of Science and Technology.

any scientific or technical question. In so doing, it will interconnect the immense resources of information services currently available in the United States.

As additional parts of a federally-coordinated program, individual agencies have taken the following steps:

The Department of Defense has established basic policy and definitions and a concept for the administration and handling of technical information within the Department. The Armed Services Technical Information Agency has been redesignated as the Defense Documentation Center in order to reflect more precisely its mission and functions. The scope of its document collection has been enlarged by permitting DDC to collect and handle Restricted Data documents. Under the supervision of DDR&E, the Center has two specific new assignments: the maintenance of a clearinghouse index of current RDT&E programs within the Department and the establishment of a centralized directory and referral service on available DoD scientific and technical information activities.

Within the Department of Health, Education and Welfare, committees on science information have been established to survey information needs and to examine activities in scientific and technical information in the Public Health Service, including the National Institutes of Health, and the Food and Drug Administration. In November 1962, the Public Health Service convened a national conference to consider recommendations for improvement in the handling of health information. The conference record provides a valuable source of ideas and recommendations regarding PHS activities. At the National Library of Medicine, a component of PHS, a computer-based Medical Literature Analysis and Retrieval System (MEDLARS) will shortly go into operation. The Department is maturing plans for a National Drug Information Clearinghouse, to begin operation in 1964.

The Office of Technical Services, Department of Commerce, has continued to expand its coverage of Federal government reports, and has set up, with the cooperation of NSF, DoD, AEC, and NASA, twelve regional centers where these reports are available to the public. It produces a bi-weekly Keyword index to provide rapid, one-place alerting to the appearance of new reports, and plans to improve its subject index as well.

The foregoing summary of achievements does not imply any feeling of complacency on the part of the Federal agencies with respect to the scientific and technical information problem. Much has in fact been accomplished, but it is clearly recognized by all that still more is urgently necessary. For example, a major effort by the Department of Commerce, NASA, and AEC to improve the rate at which technological advances achieved through Federal R&D expenditures are recognized and adopted by the non-Federal industrial sector of our economy is getting under way. Such efforts will, of course, be maintained and extended in an attempt to improve information handling activities within the Federal establishment and to increase the effectiveness of the non-Federal activities through intelligent cooperation between Government and the non-Federal organizations.

**FEDERAL AGENCY FOCAL POINTS FOR
SCIENTIFIC AND TECHNICAL INFORMATION**

<u>Department or Agency</u>	<u>Focal Point</u>
Atomic Energy Commission	Mr. Edward J. Brunenkant, Director, Division of Technical Information
Bureau of the Budget	Mr. J. Lee Westrate, Office of Management and Organization
Department of Agriculture	Mr. Foster E. Mohrhardt, Director, National Agricultural Library
	Dr. Harold C. Knoblauch, Deputy Administrator, Cooperative State Experiment Station Service (Alternate)
Department of Commerce	Dr. Donald Schon, Director, Office of Technical Services
	Dr. William Eaton, Deputy Assistant Secretary for Science and Technology
Department of Defense	Mr. Walter M. Carlson, Director of Technical Information
	Dr. Robert Stegmaier, Office of the Director of Defense Research & Engineering (Alternate)
Department of the Army	Colonel Andrew A. Aines, Director of Technical Information
Department of the Navy	Dr. M. H. Schrenk, Research Coor- dinator, Office of Naval Research
Department of the Air Force	Mr. Edward Grimes, Program Man- ager, Scientific & Technical Information
Advanced Research Projects Agency	Mr. Fred Koether, Technical Informa- tion Officer
Department of Health, Education, & Welfare	Dr. William H. Stewart, Assistant to the Special Assistant to the Secretary (Health and Medical Affairs)
Public Health Service	Dr. F. E. Kelsey, Special Assistant to The Surgeon General (Alternate)
National Institutes of Health	Mr. T. J. Kennedy, Special Assis- tant to the Director, NIH
Food & Drug Administration	Mr. Oral Kline, Assistant Commis- sioner for Science

<u>Department or Agency</u>	<u>Focal Point</u>
Department of Interior	Mr. H. H. Eckles, Assistant to the Science Advisor
	Mr. Leslie W. Scattergood, Chief, Branch of Reports, Bureau of Commercial Fisheries (Alternate)
Department of State	Colonel William R. Sturges, Science Officer, Office of International Scientific Affairs
Federal Aviation Agency	Mr. Don W. Dunn, Chief, Technical Information Division, Systems Research & Development Service
National Aeronautics & Space Administration	Mr. Melvin Day, Director, Office of Scientific & Technical Information
National Science Foundation	Dr. Burton W. Adkinson, Head, Office of Science Information Service
Office of Science & Technology	Dr. J. Hilary Kelley
Veterans Administration	Dr. M. James Musser, M.D., Assist- ant Chief Medical Director for Research & Education in Medicine
	Dr. Lyndon E. Lee, Jr., Associate Director, Research Services

STATUS REPORT ON SCIENTIFIC AND TECHNICAL INFORMATION IN THE FEDERAL GOVERNMENT

I. ROLE OF THE FEDERAL GOVERNMENT IN SCIENTIFIC AND TECHNICAL INFORMATION

The Federal Government has encouraged and supported in recent years the development of national patterns of information services which are evolving into a fully effective national system of scientific communication. Several closely inter-related steps have been taken by the Executive Branch under the leadership of the Federal Council for Science and Technology and the National Science Foundation toward achievement of the assigned goal of coordinating the country's scientific information activities both Government and non-Government. Principal mechanisms recently established within the Federal Government for the coordination of the flow of scientific and technical information to U. S. scientists and engineers have included (1) an expansion of the inventory of current research by the Science Information Exchange to include all of the natural sciences, (2) a network of regional reference centers for all Government report literature, now consisting of a network of 12 centers working closely with the Federal agencies and with the Office of Technical Services to provide improved local services to scientists and engineers, (3) a national referral center to information sources, operating since March 1963 as the National Referral Center for Science and Technology at the

Library of Congress, and (4) an increased effort of information exchange among the Department of Defense, the National Aeronautics and Space Administration, the Atomic Energy Commission, and other Federal agencies with defense-related interests. Although these four major steps involve separate organizations, their functions and activities are coordinated within the Federal establishment to provide a unified Government scientific information system.

Since information is a part of research, the Federal Government has also assumed responsibilities toward private and professional information systems which are interwoven with its own in the total U. S. scientific communication system. The scientific information efforts of the agencies, singly and in combination, have an important effect on the general information picture, just as scientific information from non-Government sources contributes to the accomplishment of strictly Federal purposes. Additionally, the Federal Government has a major responsibility for the maintenance of an effective national scientific information system because today scientific research and development play such an important role in the nation's welfare.

II. INTERNAL HANDLING OF SCIENTIFIC AND TECHNICAL INFORMATION

A. STRENGTHENED MANAGEMENT FOR SCIENTIFIC INFORMATION RESPONSIBILITIES

The present improved outlook for the Federal scientific information situation results, in part, from the cumulative actions taken by the agencies to strengthen management for their scientific information responsibilities. There is convincing evidence that most agency managements now recognize that information is an essential product of their agency's operation and that they also recognize control and dissemination of information to be a vital part of research and development. This position represents a fundamental change in the attitude of many agencies over the past five years. The growing need for top-level recognition of the importance of information was reflected in the recommendations of the report entitled, Scientific and Technological Communication in the Government (Crawford Report), prepared by a special task force in the spring of 1962 and directed toward strengthening agency management of information responsibilities. Some of these recommendations were endorsed by the Federal Council for Science and Technology and implemented through the establishment of Government-wide and agency organizations for the administration and coordination of scientific information activities.

1. Actions by the Federal Council for Science and Technology

The field of scientific information has been a frequent subject for consideration by the FCST. This has included meetings to review recommendations of the Crawford Report and the report of the Panel (chaired by Dr. Alvin Weinberg) of the President's Science Advisory Committee. Of the many recommendations made by the Weinberg Panel, the FCST has singled out for close attention two general areas of recommendations which if adopted would have significant effect on the scientific and technical information activities of the Federal agencies. These areas deal with the Government to non-Government relationships and with the delegated agent concept under which various Federal agencies would have

responsibility for information in fields that lie within their missions.

In May 1962, the FCST agreed that (a) each agency would establish a high-level focal point of responsibility for all scientific information functions within their organization, and that (b) a new Committee on Scientific Information of the Federal Council composed of these officials would be established as a mechanism for inter-agency coordination, and for development of Government-wide standards and systems of compatibility.

The Federal Council for Science and Technology is assuming increased Government-wide leadership in this field, largely through its Committee on Scientific Information and where necessary through its chairman and Director of the Office of Science and Technology, the President's Special Assistant for Science and Technology. As a consequence, staff responsibility for problems of scientific and technical information is specifically assigned within the Office of Science and Technology. The staff work of the Committee on Scientific Information is largely furnished by the National Science Foundation's Office of Science Information Service. As the Weinberg Panel pointed out, "this Office knows the most about Government and non-Government information problems, and it will continue to play the important role defined in Title IX of the National Defense Education Act in rationalizing the Government's information service."

2. Improvements in Agency Management of Information

All agencies with important scientific information programs have now established formal organizational foci of responsibility and authority for agency-wide direction and control of scientific and technical information. The nature and scope of these organizational assignments are fully described in the statements of the individual agencies attached to this report.

Within the past year, several agencies with major research and development programs

have undertaken comprehensive surveys of their technical communication operations and their organizational structures for handling scientific information. Other agencies, including AEC and NASA, had previously undertaken over-all management and program analysis. To coordinate intra-agency information activities and to provide leadership and direction for the development of new programs, a number of agencies such as the Departments of Agriculture, Commerce, Defense, Federal Aviation Agency and Health, Education and Welfare have recently established working groups or committees to give a thorough review to all or significant parts of their scientific and technical information activities with a view toward improving these. Noteworthy among agencies conducting extensive management examination have been the Department of Health, Education and Welfare and the Department of Defense.

Within HEW the organization of committees and appointment of staff have served to provide a mechanism for the coordination and cooperation of scientific information activities between constituents of the Department and between the Department and other agencies of the Federal Government. Committees on science information have been established to survey information needs and to examine agency activities in scientific and technical information in the Food and Drug Administration and in the Public Health Service, including the National Institutes of Health. In November 1962, the Public Health Service convened a national conference to consider recommendations for improvement in the handling of health information. The conference record provides a valuable source of ideas and recommendations regarding PHS activities, several of which have already been implemented.

With the Department of Defense (the biggest single producer of scientific information), the responsibility for over-all management control of scientific information has been assigned to the Director of Defense Research and Engineering and additional steps have been taken within each of the military departments to assist in coordinating scientific and technical information on a Department-wide basis. The Armed Services Technical Information Agency has been converted to the Defense Documentation Center (DDC) and given responsibility for the prompt announcement and secondary distribution of technical documents to the DOD agency and contractor community. A series of DOD instructions has been issued to expedite the execution of policy and organization assignments provided in the over-all DOD plan.

3. Inventories of Agency Information Activities

The National Science Foundation has under way a survey of Government agencies' scientific and technical information activities and these are being published as Scientific Information Activities of Federal Agencies. To provide a clear picture of expenditures related to scientific and technical information, the Foundation has added a supplement to its yearly study of Federal Funds for Science, which covers principally the direct costs of information activities within the agencies and assists the Bureau of the Budget in compiling financial data for budgetary analysis. Projected surveys of information costs in industry and universities, including extra-mural activities supported by the Federal Government, are described in the section of this report on Annual Agency Funding and Program Review.

The compilation of a comprehensive inventory of the scientific and technical information activities of the Department of Defense has been under way for a number of months and will be concluded this summer. This inventory will provide the basis for further steps toward the coordination of all related technical information functions in the Department. Associated with the inventory is the compilation of financial data on the annual costs of operation of each of the major functions in the technical information field.

Similarly, the Public Health Service Committee on Science Information has prepared a draft Catalog of Science Information Activities that lists and identifies such activities with some precision, as a prerequisite to identifying and measuring what is good, what can be improved, and what is missing.

B. COMMUNICATION OF SCIENTIFIC RESEARCH RESULTS

1. Improvement of Federal Research Management

Information is one of the many tools that administrators of research and development must have. In the rapidly expanding complex of new Federal programs, the possibility of waste and poor management exists if research administrators and investigators can not readily inform themselves on current and past research activities in their fields of work. Federal agencies are giving increased attention to methods to minimize wasteful duplication of research effort by improved communication,

including dissemination of scientific information. An important R & D management function in Government is the maintenance of an adequate information system oriented toward both broad and specific aspects of the agency missions for both their own needs and those of the performing scientists and engineers. Information thus represents a form of management tool permitting compilation, comparisons, and analyses of agency research efforts to determine where the emphasis is being placed, whether important gaps, imbalance, or unknowing duplication of effort may exist, whether manpower resources are being deployed to advantage, and whether the allocation of funds and assignment of projects is properly keyed to the major objectives of the various agencies and of the nation. The coordination of scientific and technical information activities within the individual agencies, and on an interagency basis, has a key role in the improvement of Federal research management.

2. Coordinated Dissemination of Research Reports

As noted by the Weinberg Report, "The essence of the internal technical information problem faced by the Government is control and dissemination of the information and the intelligence contained in its research reports." There has been developed within the Executive Branch a pattern of close cooperation among the Atomic Energy Commission, the National Aeronautics and Space Administration, the Department of Defense and other Federal agencies. The present system provides for Federal agencies with research and development programs to cross-service one another's organizations and contractors directly. That is, a contractor or element of any one of the agencies is provided the same service as if that contractor or element were part of the agency itself. For example, services of the Defense Documentation Center are provided to contractors of AEC, NASA, Interior, HEW, and others. AEC and NASA have, in recent weeks, also announced agreement on a standard microform for report literature which will have far-reaching results for improved dissemination and greater use of research reports.

OTS recently has increased its coverage of the report literature generated by Federal agencies, and reports of contributing agencies are available in the twelve regional Federal Technical Report Centers, increasing many-fold the number of scientists and engineers with ready-reference access to these documents. In cooperation with AEC, DOD, NASA,

and NSF, the Office of Technical Services held a meeting in February 1963 with the librarians responsible for the report centers for the purpose of improving the servicing and utilization of the interagency collections of reports.

3. Government Abstracting and Indexing Services

The Federal agencies have made significant strides in the improvement of abstracting-indexing mechanisms for the announcement and availability of Government research reports. The importance of advances in this area of information handling is underlined by the fact that abstracting-indexing is a principal means available for providing scientists with current awareness of their fields of interest as well as guides for retrospective search of the world's literature. In brief, abstracting-indexing of the significant literature is central to effective scientific reference services both within and outside Government.

a. Unified index to Government literature—To satisfy an urgent need to organize the rapidly expanding body of report literature, the National Science Foundation, in cooperation with AEC, DOD, NASA, OTS, and other concerned agencies, are taking steps necessary to assure that one over-all index to report literature comes into being. This is not intended to replace the present diversified indexes that serve the individual needs of specific agencies and disciplines, but to supplement them with a broader and more generalized indexing system for interdisciplinary and interagency use, and for use by the U. S. scientific community at large.

The first step toward this unified index has been publication of a semi-monthly permuted title index, which the Foundation has supported in cooperation with the Office of Technical Services. While not serving the purposes of a more sophisticated index, this permuted title index nevertheless permits scientists to scan one, rather than several, documents in reviewing the report literature.

Other experiments are being conducted to see if the various indexing systems, which have been developed by the major report producing agencies to fit their particular needs, can be consolidated with the aid of a computer into one unified index for all Government report literature.

To this end, studies have been conducted by NSF to determine the feasibility and

practicability of converting the indexing terminology of the large agency information systems into a common vocabulary. An experimental study involving the Atomic Energy Commission and the Defense Documentation Center (of DOD) indexing vocabularies has been completed and a new project calls for the production of a dictionary of equivalents among the indexing vocabularies used by AEC, DDC, and NASA - the three agencies which, with their contractors, turn out the great bulk of Federal research reports. Results of preliminary investigations look promising and it is expected that it will eventually be possible to rapidly transfer information among the various indexing systems of the Federal agencies and thus be able to develop a comprehensive, unified index to Government research and development literature.

b. Improvements in agency abstracting-indexing services— Perhaps the most important innovation in the information field is the machine organization and publishing of indexes of current literature. In regard to individual agencies, at the present time every agency with a major abstracting-indexing service either has actually introduced or is planning mechanized systems to expand coverage and to speed up production of their services. These agencies and their services include the Department of Agriculture (Bibliography of Agriculture), the Atomic Energy Commission (Nuclear Science Abstracts), Department of Commerce - Office of Technical Services (U. S. Government Research Reports), Department of Defense - Defense Documentation Center (Technical Announcement Bulletin), Department of Health, Education and Welfare - National Library of Medicine (Index Medicus), and the National Aeronautics and Space Administration (Scientific and Technical Aerospace Reports).

In providing service to the non-Government scientific community, the Federal agencies cooperate with OTS in the announcement and availability of Government research reports. To this end, ADC, NASA and DOD are now exchanging abstracts and are furnishing indexing and abstracting information to OTS at the time it is prepared for their own information bulletins.

Notable among recent actions taken by agencies to improve their abstracting-indexing services are (1) the preparation by the National Agricultural Library of a new "current awareness" publication to list all new titles received, issuance of a monthly subject index to the Bibliography of Agriculture, and

establishment of a library network with the land-grant institutions for cooperative bibliographic projects; and (2) publication by the Atomic Energy Commission of a 5-year (1951-1961) cumulative subject, personal, and corporate author index for Nuclear Science Abstracts (NSA), for which three cumulative indexes are now available for quick retrospective searching of all atomic energy literature abstracted in NSA in the past 15 years. To speed up abstracting and indexing coverage, AEC has also recently completed arrangements with the American Institute of Physics for advanced page proofs of articles scheduled for publication in the principal physics journals.

Machines, including computers in some cases, are being used to great advantage to speed the compilation and production of printed indexes. Among other organizations, the Atomic Energy Commission, the Department of Defense (DDC), the National Library of Medicine and the National Aeronautics and Space Administration, are making use of machine techniques, which take the indexing as done by individuals and rapidly organize it for printing. These machine techniques have shortened the time for production of indexes by several months and have made it possible to incorporate into current issues of abstracts publications indexes which previously had to be issued several months or even more than a year later.

4. Improved Reporting of Research Results

Federal agencies are also giving increasing attention to improving the quality and speed of their reporting on research results. For example, the National Bureau of Standards, which has always had a strong publication program, has taken steps to speed up its review process without sacrifice of quality and to encourage prompt publication. Consistent with the findings of the Weinberg Panel, the Bureau is encouraging publication of significant results and discouraging publication of results not worthy of the open literature. In another case in point, several bureaus in the Department of Interior have recently concentrated on improved distribution of information to their contractors. For example, the Office of Saline Water, which accomplishes research mainly through contracts and grants, has established new procedures for the rapid review and interchange of monthly and bi-monthly reports. In a move to make the research reports originating in the bureaus in the Department of Interior more widely available to other agencies and to the scientific community, the central library,

with bureau cooperation, has worked out details of a plan with the Office of Technical Services, to supply research reports to the regional Federal Technical Report Centers. The Department is sponsoring a publication called RECAP, a bulletin of abstracts of selected current articles, translations, reports, and papers on water resources development related to the program of the Bureau of Reclamation.

A joint project has been started by OTS and DOD to identify scientific and technical information which is not under security classification, but is being withheld from the public for a variety of reasons. A representative number of such research reports have been identified and DOD is now reviewing their status to see whether the withholding is valid.

The National Institutes of Health, in their sponsored studies of user needs, are giving consideration to the problems of privileged information whose dissemination is restricted either for the protection of the investigator or for the protection of national security.

C. INFORMATION ON CURRENT SCIENTIFIC RESEARCH

The question of who is doing what research where can be increasingly answered with respect to Government-sponsored research. An index of current research projects including such information has an important bearing on administrative planning and resources allocation, as well as definite value to the investigator in his need to gain ready access to prepublication information. Noteworthy advances have been made in recent months by the Science Information Exchange (SIE), in extending and broadening its coverage and services on current research projects. At the request of COSI and with the endorsement of the Federal Council, the Director, Office of Science and Technology has recommended that fiscal and managerial responsibility for the SIE be transferred to the National Science Foundation. The action was taken to eliminate budgetary and administrative problems that have slowed progress in this area. Steps necessary to make the change are now in progress. In addition, other methods for providing improved cross transfer of information are being tried by agencies involved in Government-wide programs.

1. Science Information Exchange

The Science Information Exchange, Smithsonian Institution, has almost doubled its collection of current research records during the past year, from about 30,000 to about 55,000. About 90% of all Federal research projects in the life sciences are now registered. Registration of physical sciences research began in May 1962 and now includes over 16,000 projects. This is a large proportion of the extramural Federal grant and contract program for basic and applied research that is available. Collection of data on the intramural Federal programs is well under way, and the major areas not now registered have been identified and their input is being negotiated with the agencies, offices, and bureaus that have the records.

An equally significant index of SIE progress is the number of new research support agencies that have begun to register their programs with SIE. Research components of the Departments of Agriculture, Commerce, Defense, Health, Education and Welfare, and Interior and the Federal Aviation Agency have all started the registration of their programs, so that nearly all Federal agencies with significant research interests in natural sciences are now participating. New research programs have been added from twenty Federal offices, bureaus or other comparable components. An additional eight new office or bureau programs are being assembled for early delivery.

As the accumulation of Federally-sponsored research programs approaches a comprehensive coverage, increasing attention has been directed to the non-Government organizations supporting research. State governments, universities, and industrial research laboratories are registering their new research programs with SIE in increasing numbers. About eighty foundations and other private research-sponsoring groups are also contributing information on research supported by their organizations. Cooperative arrangements with industry present the most difficult problem among non-Government organizations because of the competitive secrecy that envelopes their in-house research.

The output of SIE information services to all areas of the scientific community continues

to increase at about 25% per year in the life sciences field. SIE is furnishing increasing information in the physical science fields as the collections become more comprehensive. In the coming year SIE will intensify its efforts to make these services more widely known throughout the scientific community.

2. Inter-Agency Transfer of Information on Current Research

A consolidated annual report on current research projects is now being issued by several agencies in addition to providing such information to SIE, recent examples being the National Bureau of Standards, the Public Health Service, U. S. Weather Bureau and Department of Interior Bureaus of Mines, Geological Survey, Sport Fisheries and Wildlife. In the latter instance, the need to conduct a survey of all meteorological research and development projects will shortly result in an annual catalog of current research, giving for the first time an authoritative, comprehensive picture of the meteorological research effort supported by the Government. An example of a more informal procedure for coordinating research of similar interest between two agencies is the recent agreement for cross transfer of project status reports between the Office of Research and Development, Maritime Administration, and the Department of the Navy.

3. Scientific Meetings, Conferences, and Seminars

In many fields of research, personal interchange among scientists at formally arranged meetings, conferences, and seminars, constitutes the most powerful, immediate and effective means of conveying information on new discoveries and research still in progress. Methods of personal communication have become a major channel for the exchange of scientific information and an indispensable supplement to publication and distribution of written materials. Federal agencies are giving support for the various aspects of the personal interchange process in the improvement of communications. For example, the Public Health Service, through its many programs and activities, provides extensive support for both formal and informal conferences, symposia and other meetings as a basic means of enlarging communication in the biomedical sciences.

Several agencies have also taken steps to provide increased interchange of both research plans and results through participation in

seminars and scientific meetings. Sometimes such exchange of information is carried out at the field laboratory level, as for example by bureaus in the Department of Interior, and at other times at inter-agency meetings and symposia sponsored or cosponsored by agencies and scientific societies. Such meetings serve as a channel for communication of information prior to publication.

D. NEW AND IMPROVED SYSTEMS AND SERVICES

1. Specialized Information Centers

There has been continued growth in the number and use of specialized information centers both within the Government's own laboratories and also through support by some Government agencies of information centers in subject areas of particular interest. The Weinberg Panel has called the specialized information center "... a major key to the rationalization of our information system" and has urged that more and better specialized centers be established.

The Department of Defense leads other agencies in the number of specialized information centers receiving support with approximately 100 now functioning in their fields of competence and disseminating evaluated, condensed "state of the art" reports. DOD plans to bring these information centers into a more effectively coordinated network in which there will be improved coverage of the major scientific and technical disciplines of direct interest to the Department. The National Institutes of Health is planning for a program of specialized information evaluation centers, three of which may be funded in FY 1963. Critical reviews, general-purpose summary monographs, and similar selective digests would be produced by each evaluation center. Similarly, the Atomic Energy Commission has already established more than a dozen such centers at its national laboratories, including two within recent months, one for radiation shielding and one for nuclear safety. Additional information centers are being planned by other agencies to cover a wide variety of scientific and technical areas in depth.

a. Proposed drug information clearinghouse— As a first step in organizing a central Drug Information Clearinghouse, the Department of Health, Education and Welfare has currently under way a study to define specific needs of potential participants in the system. The study would concurrently determine the

volume and sources of drug information—published and unpublished—in order to devise a systematic acquisitions program.

The establishment of a Drug Information Clearinghouse would materially assist the ongoing activities of a task group on drug toxicity and reaction reporting operating in the Clinical Center of the National Institutes of Health. The task group objective is to permit the continuing study, analysis, and reporting of data on the toxicity of, and adverse reactions to, drugs in current use. In this connection, procedures for reporting of untoward drug reactions have been re-examined recently within the Veterans' Administration Central Office and further steps taken to coordinate internal VA reporting procedures with needs of the Food and Drug Administration.

b. National directories of information sources—To provide a central information source on the multitude of scientific information services available within and outside the Government, and to avoid gaps and duplication of coverage, steps have been taken by the newly established National Referral Center for Science and Technology (Library of Congress) to publish directories of available information sources, both Government and non-Government as rapidly as possible. All Federal agencies are contributing data on their special information sources, and more than 3,000 information sources of private organizations have thus far been identified and are being processed into the Center's control and retrieval system.

2. Critical Reviews

Because research reports and journal papers are published in such large numbers and are of uneven quality, mechanisms for culling the scientific literature are in operation, under development, or being explored by Federal agencies. So that all significant contributions to science will be readily accessible to research workers, the pay-dirt contributions must be made extraordinarily visible lest they be buried among the many contributions of less value. A recommendation of the Weinberg Panel urged all agencies to consider publication of reviews in their fields of interest.

A new high-level periodical, Reviews of Geophysics, is felt by leaders in the field to answer the need of bringing together advances on the broad fronts of this increasingly important field of science. It is being published by the American Geophysical Union with National Science Foundation support. To meet

the needs of a particular area, the Geological Survey has commenced a new publication entitled Geological Survey Research 19, which contains both general synopsis and short papers describing the results of current geologic and hydrologic studies.

The Atomic Energy Commission has undertaken publication of a new quarterly review journal, Isotopes and Radiation Technology. This new critical review joins four other AEC journals (Nuclear Safety, Power Reactor Technology, Reactor Fuel Processing, and Reactor Materials) which, as noted by the Weinberg Panel have been received enthusiastically by the scientific and technical community. Agricultural Science Review is another new review journal published by the Department of Agriculture's Cooperative State Experiment Station Service. Through comprehensive critical review articles, this journal will provide to administrators and key scientists an authoritative source of information on published research relating to selected facets of agriculture, research in progress, trends in research, and managements of research programs.

The Public Health Service is planning an increased production of critical reviews of various fields of health-related research. Under consideration is a senior award system to finance individual outstanding scientists to prepare thoroughgoing assessments of current research and development in specified fields of science.

A departure from traditional publishing concepts is represented by Science and Engineering Television Journal. Managed by the American Association for the Advancement of Science with National Science Foundation support, this series of programs begun in December 1962, is an experiment in the use of broadcast television (as distinguished from closed-circuit TV) for scientist-to-scientist communication.

3. Numerical Data Collection and Dissemination

An immediate need exists to speed the flow of reliable numerical data in useful form to scientists and engineers. As a result of the creation of numerical information more rapidly than it can be digested and consolidated, research workers and engineers are often hindered in their work by the difficulty of finding and assessing numerical information. With the advice and concurrence of the Federal

Council, the Director of the Office of Science and Technology has established a National Standard Reference Data System as a matter of Federal policy and has asked the National Bureau of Standards, Department of Commerce, to administer the System. This activity looks forward to a large-scale program in collaboration with the Office of Critical Tables of the National Academy of Sciences - National Research Council to stimulate the collection, evaluation, and dissemination of numerical data of chemistry, physics, engineering, and the earth sciences. Plans call for substantial and continuing participation by DOD, NSF, NASA, AEC, and other bureaus or agencies having a direct interest in and responsibility for sections of the task.

4. Information Systems Development

a. Language compatibility among information systems— The increasing growth of Government information systems, mechanized or not, has underlined the need for improving operational compatibility among the various systems so as to promote effective exchange of information. To this end, an Ad Hoc Inter-agency Study Group on Language Compatibility in Mechanized Storage and Retrieval Systems has been formed under NSF sponsorship to provide a coordinated working-level approach to the study and development of improved vocabulary compatibility. The group includes membership from the Atomic Energy Commission, Department of Defense (Defense Documentation Center), Library of Congress, National Academy of Sciences - National Research Council, National Aeronautics and Space Administration, National Library of Medicine, National Science Foundation, Office of Technical Services, Patent Office, National Agricultural Library, and the Science Information Exchange. This activity has been transferred to the supervision of the Committee on Information of the Federal Council.

b. Mechanized information systems— Several Federal agencies have recently automated parts of their information processing systems. The real bottleneck to fully mechanized systems for organizing and searching large collections of scientific information is not technological, but intellectual. As emphasized by the Weinberg Panel the storage of information in computers is easy enough but the ways by which retrieval systems may selectively retrieve either documents, facts, or both, are proving a difficult problem. The new information storage systems which are in operation generally retrieve documents rather than information.

Mechanization of information activities is being carried out at the National Library of Medicine, Navy Bureau of Ships, National Aeronautics and Space Administration, Patent Office and the Defense Documentation Center. Studies for introduction or further improvements to information systems, especially of a mechanized nature, are being conducted by the Public Health Service, National Aeronautics and Space Administration, Department of Agriculture, Department of the Air Force, Patent Office, Atomic Energy Commission, Office of Naval Research, the National Science Foundation and the Office of Technical Services.

One of the very large information systems that is partially mechanized is that of the Defense Documentation Center (formerly Armed Services Technical Information Agency). This organization seeks to keep ready at hand all of the research results obtained by or for the military departments and other DOD components. Descriptors indexing each incoming report are stored on magnetic tape that can be run through a computer. Upon request, the computer prints out cards telling where to find relevant reports in the files and also, if desired, will automatically reproduce bibliographic descriptions of the selected documents. This system first went into operation with magnetic tape in 1961. At the present time, DDC has steps under way to improve the efficiency and expand the scope of its mechanization program.

Another information system which will become operational in 1963 is the Medical Literature Analysis and Retrieval System (MEDLARS), developed for the National Library of Medicine. At the heart of MEDLARS is a digital computer. Information can be fed into this system through punched-tape representing the indexing done by the library staff. Three types of products will be derived from MEDLARS. First, it will provide increased high-speed composition capacity for the production of *Index Medicus*. Second, it will provide recurring bibliographic listings of references selected in accordance with the predetermined requirements of particular research fields. Third, it will provide search and retrieval capacity to answer, on demand, queries from individual research installations concerning newly published information bearing on their immediate problems.

An example of a complete information processing system is that contracted for by NASA. Its computer retrieval program is now in full operation. Magnetic tapes, which duplicate the information "store" at the NASA

central processing facility, are now being used on a decentralized basis by selected NASA Centers and contractors, with provision for updating on a bi-weekly schedule. Availability of these retrieval tools throughout the NASA complex is a further implementation of its plans to provide a high degree of local access to the results of NASA technical program efforts.

c. Scientific publication— Present methods of publishing scientific research results are fast becoming obsolete. New and improved publication techniques and production methods are being developed and experimented with in ways which will provide the ready availability of information needed by research scientists and engineers. Experiments are under way both within and outside Government. One new method which is expected to have long-range beneficial effects on publishing in many scientific fields is the application of high-speed photo typesetting in chemical and mathematical publishing. As noted in the section of this report dealing with Agency Abstracting and Indexing Services, the machine organization and publishing of indexes of current literature is under way or planned in several agencies. Experiments are also under way whereby edited text can be composed by the use of the computer and new electronic optical composing machines onto plates ready for the press. This technique will be used this year by the National Library of Medicine in its MEDLARS project. In this case, the magnetic tape processed in the computer is used to activate a very high-speed composing device capable of producing photographic masters for printing.

5. Availability of Information on Foreign Research

Federal agencies have stepped up and further strengthened their programs for achieving availability of significant scientific and technical information published in languages other than English. Recent activities have centered on improved translation services, the acquisition and exchange of foreign scientific publications, and the production of foreign scientific information.

Major Government translation programs, including those of the National Science Foundation and the National Library of Medicine, are beginning to shift in emphasis from cover-to-cover translation to a selective translation basis. It is believed a highly selective service for foreign journals containing material of varying quality is more directly responsive to

the needs of U. S. research workers. In addition, scientific societies are being urged to re-examine their translation needs. Indicative of improved translation services being provided by the National Library of Medicine was the appearance in January 1963 of the first issue of the Translation Supplement to the journal Federation Proceedings (Federation of American Societies for Experimental Biology). This effort completes the conversion of the Library's Russian Scientific Translation Program—previously limited to cover-to-cover translation of nine Soviet research journals containing material of varying quality—into a highly selective service directly responsive to the needs of American biomedical research. A recent example of NSF support of a selective translation journal is International Chemical Engineering, inaugurated by the American Institute of Chemical Engineers, which concentrates on the literature of the Sino-Soviet bloc.

Federal agencies added to their foreign information resources in the past year through continued cooperative efforts in sponsoring overseas translation activities under Public Law 480. This program is being carried on under NSF coordination in Israel, Poland and Yugoslavia using foreign currencies through the sale of U. S. agricultural commodities overseas.

Scientific information in most research fields travels freely across national boundaries. Cooperation with international organizations is increasing. A recent example is the discussion by the Public Health Service with the World Health Organization looking toward establishing an International Drug Information Clearinghouse. Agencies including AEC, DOD, NASA, and NSF, among others, are stimulating exchange of information with foreign countries and international organizations. Illustrative of enlarged publication exchange arrangements is the recent large-scale exchange worked out with NSF support by the American Mathematical Society and the Lenin State Library whereby multiple copies of some 900 Soviet scientific periodicals come directly to approximately 75 U. S. research libraries. The American Mathematical Society provides U. S. publications in return.

Considerable emphasis continues to be placed by NSF on studies of scientific research and information activities in foreign countries. Current efforts include compilation of directories of foreign scientific research institutions and scientists, reviews of the state-of-the-art of sciences in foreign countries, science information activities in foreign countries and

international organizations, and preparation of bibliographic guides to foreign scientific publications. Recent examples of these are cited in the appendices to this report.

On the international scene, the Department of State has issued new instructions to their science officers aimed at improved reporting of science activities overseas. The first of a series of reports has now appeared ("Organization of Scientific Activities in India") and others are being prepared. Such reports, issued with the assistance of the National Science Foundation, are timely and informative, giving U. S. scientists a current insight concerning science in foreign areas.

E. ANNUAL AGENCY FUNDING AND PROGRAM REVIEW

As an important step in effecting significant improvements in scientific information activities in the Executive Branch, an annual review has been instituted of budget and program plans of each agency for this field of activity. The information collected makes it possible to compare relative outlays for scientific and technical information with other areas of research and development activities.

Beginning with the preparation of the 1964 budget, a further step in this direction was taken by collection and review of data on the major long-term issues which will affect government programs and budgets for scientific information through FY 1967. In May and November 1962 and again in January 1963 the National Science Foundation, at the request of the Director of the Bureau of the Budget and the Special Assistant to the President for Science and Technology, collected financial and program data on agency plans for 1964 using a category breakdown by major type of information activity. Thus, trends indicated by agency program plans as evidenced in an early stage of the budget cycle are reviewed to determine whether an adequate level of support is being maintained within each agency and also whether programs of joint interest are being

effectively coordinated. This effort is being carried out as part of the over-all plan to review science activities of the Federal Government, particularly several selected fields of science of broad national or Government-wide interest.

1. Increased Agency Support for Information Activities

Federal agencies are continuing their efforts to obtain additional and more reliable cost data on science information activities, a task made difficult because information handling is so closely integrated with other elements of particular research and development programs.

The budgetary data available for fiscal year 1964 together with future agency planning demonstrates a growing recognition of the importance of science information to the research and development effort of the nation. Substantially increased research and development is programmed for scientific communication and documentation including methods of information retrieval, storage and dissemination, machine translation, and advanced mechanization techniques. Considerable increases are also planned for the publication and distribution of documents and for bibliographic and reference services, including abstracting and indexing services. Likewise, there are some increases programmed for scientific symposia and technical meetings, representing an orderly growth in this form of information exchange.

2. Projected Surveys of Information Costs in Industry and Universities

A survey of costs of industrial scientific and technical information activities, including extra-mural activities supported by the Federal Government, is being planned by the National Science Foundation for 1963. It is also planned that in 1964 the survey of costs of scientific information activities will be extended to academic institutions as well as other non-profit institutions.

III. FEDERAL COOPERATION WITH PRIVATE AND PROFESSIONAL ORGANIZATIONS

A. SUPPORT OF NON-GOVERNMENT PUBLICATIONS AND RELATED SERVICES

Various policies and practices for assuming a just share of the support of private scientific publications have been adopted by Federal agencies through the years, on the basis that the Government should assist in the support of publishing efforts which report the results of Federally-financed research and development. For example, page charges of scientific journals have been paid, journals in financial difficulty assisted, the launching of new journals aided, and the publication of monographs and books supported. Since the activities of the Government in this area influence the supply and demand of scientific and technical publications in the private economy, the Federal Council for Science and Technology plans to review the criteria used by the Federal agencies in making decisions for supporting non-Government publications. As a preliminary step, the National Science Foundation is undertaking an extensive study of Government support of non-Government publications—primary journals, review journals, abstract journals, and bibliographic publications—looking toward the development of uniform agency policies.

1. Support of Primary Scientific Publication

Two general approaches have been made to the support of primary scientific publication: one is to link publication support as directly as possible to research support; the other is to provide separate, direct subsidy for publication. The former mechanism was approved by the Federal Council for Science and Technology in October 1961 and is now a part of the support structure of more than 45 professional, scientific journals in a variety of subject fields. Among the societies recently adopting a page charge policy, has been the American Chemical Society which initiated such charges in January 1963 for eight of its periodicals. It is believed that the payment of page charges to primary journals will, in two more years, have shifted a potentially large, direct subsidy load directly

into government, industry, and academic research budgets where that burden properly belongs.

The National Science Foundation has been and continues to be the principal agency granting direct subsidy for the support of primary publications, as such, and during the last year assisted in the support of 11 journals and 29 monographs. Other Federal agencies such as the Atomic Energy Commission, Department of Health, Education, and Welfare, National Aeronautics and Space Administration, the Department of the Navy, and the Weather Bureau, have provided limited funding directly to private publications is part of the agencies' basic R & D missions. Thus, for example, the Atomic Energy Commission, in cooperation with private publishers, published seven scientific and technical books during the past 12 months. In addition, AEC continued its scientific monograph program with the American Nuclear Society, the American Institute of Biological Sciences, and the American Industrial Hygienic Association.

2. Support of Abstracting and Indexing Services

The rapid growth of world publication of research results has made abstracting-indexing the keystone of scientific reference service. Because of increasing costs U. S. abstracting and indexing services have raised subscriptions in recent years to the place where any additional increases will result in no increase in income because of cancellations. Yet today, these services are covering effectively only about one-half of the world's worthwhile scientific and technical literature. The National Science Foundation is taking steps, financial and otherwise, to assure that these services are adequate to meet the needs of scientists and engineers. At the same time, the Foundation is stimulating co-operation as noted below among U. S. abstracting-indexing services, Federal and private, and between U. S. services and their significant foreign counterparts. (An account of recent actions to improve coordination of Federal agency services appears in the section on report literature.) A

World Guide to Abstracting and Indexing Services, listing over 1,800 services, was prepared by the National Federation of Science Abstracting and Indexing Services with NSF support, and published in April 1963.

Specific steps taken in recent months in this area by Federal agencies have been (1) NASA's coordination with the American Institute of Aeronautics and Astronautics for a cooperative program in the abstracting and indexing of all literature related to space, described below; (2) completion of a report to the National Federation of Science Abstracting and Indexing Services, underwritten by NSF, which will serve as the basis for development of a national plan for abstracting and indexing aimed at improved coverage, more responsive services, and elimination of needless duplication; (3) improved coordination of programs for the support of a number of specific abstracting and indexing services such as Meteorological and Geoastrophysical Abstracts and Bibliography, Mathematical Reviews, the Arctic Bibliography, and Geoscience Abstracts. For example, the support by several Government agencies of the compilation and publication of Meteorological and Astrogeophysical Abstracts by the American Meteorological Society has been put on a unified, coordinated basis through a contract now administered by the Weather Bureau in behalf of all supporting agencies. The scope and depth of the coverage of meteorology, oceanography, hydrology, glaciology, and astrophysics by this abstracting service have been increased.

Within the past six months, a beginning has been made to transfer support of abstracting services from various parts of the National Institutes of Health to the extramural program of the National Library of Medicine. The extramural program will be the principal Public Health Service focus for the support of abstracting services. This consolidation will reduce present costs of abstracting, avoid duplication and omission, and provide for the uniformity of indexing and format necessary for automated operations.

The development of cooperative relationships between Government and non-Government information systems is illustrated by the program begun in January 1963 between the National Aeronautics and Space Administration and the American Institute of Aeronautics and Astronautics (AIAA) which will provide comprehensive coverage of the world's output of information in the aerospace sciences. As noted earlier in this report, the NASA abstract journal, Scientific and Technical Aerospace Reports

(STAR), is now devoted to coverage of the world's aerospace report literature. The AIAA journal, International Aerospace Abstracts (IAA), announces the world's journal and book literature. This cooperative undertaking is designed: (1) to eliminate duplication in coverage of the rapidly expanding aerospace science literature; (2) to provide for standardization of format and indexing patterns; and (3) to expand in depth the coverage of the world's scientific literature of immediate interest and value to participants in our national aerospace program. STAR and IAA, both published on a semi-monthly basis, now provide one standard bibliographic guide to aerospace science information.

Further, in regard to Government support of non-Government services, NSF has assisted Chemical Abstracts, Biological Abstracts, Engineering Index, and Sociological Abstracts in developing programs that increase the effectiveness of the information services of these organizations by making their abstracting and indexing publications more responsive to the needs of scientists and engineers, and in the development of mechanized systems that should enable these organizations to develop information services based on their abstracting and indexing. Also, of great potential value to improved coverage of biomedical literature, representatives of Chemical Abstracts, Biological Abstracts, Excerpta Medica, and the National Library of Medicine have held recent meetings in an attempt to reach agreement on terms and systems for indexes and abstracts.

B. BASIC AND APPLIED RESEARCH ON INFORMATION PROBLEMS

Federal agencies have a large number of research and experimental projects currently underway to devise new methods for organizing and searching for information in scientific and technical papers. For the most part, research in this field is Government-supported through grants or contracts to universities and other non-profit institutions and in some cases to industry or private organizations working in this field. The coordination of a national program for the support of research on information problems is the responsibility of the National Science Foundation operating in close conjunction with both private research-supporting organizations and with other Federal agencies which support research related primarily to operating problems in their fields of mission. The Air Force Office of Aerospace Research and the Office of Naval Research also support continuing projects on storage and retrieval, and particularly mechanized literature searching techniques.

The National Bureau of Standards conducts a major program of research in information handling in support of specific other-agency programs, in support of the programs of the Bureau, and in support of the general needs of the scientific and technical community. A few of the principal components of the program currently active are listed in the statement supplied by the Bureau. Additionally, at the present time every agency with a major scientific information facility is conducting operational research in techniques for processing and disseminating scientific and technical information. Research is also being conducted by agencies to identify long-range information objectives and data handling problems associated with the most effective communication of scientific and technical knowledge in their fields. Agencies conducting research in this latter category include AEC, NASA, and the Patent Office, among others.

Several recommendations of the PHS-sponsored Conference on Health Communications (November 1962) pointed out the need for increased research in communications. As a consequence, it is expected that a Scientific and Technical Information Resources Branch will be established in the National Institutes of Health to consolidate and coordinate NIH planning and activities to cope with problems of gathering and handling scientific information required by researchers and to develop centers for research on information management.

1. Mechanisms of Coordination of Research

Research projects currently supported by the National Science Foundation and by other Federal agencies are described in the November 1962 issue of the semiannual report, Current Research and Development in Scientific Documentation, published by the Foundation. This guide to current research projects both here and abroad, Government and non-Government, provides a means for coordination and exchange of information among working groups. In addition, Nonconventional Technical Information Systems in Current Use (last issue, October 1962) reports on information systems embodying new principles for the organization of subject matter or employing automatic equipment for storage and search. Other mechanisms of coordination of information research among Federal Agencies include existing committees such as the Interagency Group for Research on Information Systems (IGRIS); the Committee on Documentation of the U. S. Intelligence Board (CODIB); and the Interagency Committee on

Mechanical Translation Research. The inter-agency agreement on a "Joint Research and Development Program for Automatic Language Processing" is discussed below.

The Research Information Center and Advisory Service on Information Processing, which is supported jointly by NSF, the National Bureau of Standards, and the Council on Library Resources, has recently issued a state-of-the-art paper on "Information Selection Systems Retrieving Replica Copies." Other state-of-the-art reports will be issued soon. One covers research in the field of automata theory and discusses the relation of this work to information retrieval research. Another covers work to date on automated composing systems and techniques which are being developed for and used in the printing of documents, books, journals and other publications.

2. Communication Patterns and Information Needs of Scientists

In the area of communication patterns and information needs of scientists, the National Science Foundation is supporting promising on-going projects aimed at developing a comprehensive understanding of current scientific communication practices and problems. Such projects include, for example, Lehigh University's studies in the methodology of measuring information requirements and use patterns; the American Psychological Association's coordinated study of information exchange in psychology; and the program of documentation research being carried on by the American Institute of Physics which covers various aspects of the problem of communication among physicists. The Public Health Service, including the National Institutes of Health, also sponsors a number of projects in this area, including studies on the flow of biomedical information to medical practitioners, the literature use patterns and needs of members of the medical profession, and the transmittal of biomedical information from its generation to its ultimate use through the complex of systems and services involved in the handling of such information.

3. Information Organization and Searching

The research projects in this area being pursued within Government agencies or supported extramurally are concerned with the various aspects of analysis, organization, encoding, and searching of the subject content

of large collections of scientific information. Studies and experiments are being conducted on various types of indexing techniques and their attendant problems of vocabulary development and control. Some of the work is aimed at mechanization of methods and techniques for processing the language of documents and their graphic elements, such as diagrams. Some of the more basic work is concentrated on evolving a general theory of information storage and retrieval processes.

The Patent Office and the National Bureau of Standards collaborate on an extensive program of research on the mechanization of searching procedures in the Patent Office. The latter conducts related research as well, such as the work on automatic language and picture processing supported by NSF.

The bulk of the Federal support to extramural research in this area is provided by the National Science Foundation, the Rome Air Development Center, the Air Force Office of Scientific Research, the Office of Naval Research, and the National Institutes of Health. The research areas covered by current major projects supported by these agencies indicate the directions of their programs.

a. National Science Foundation: computer-aided analysis of English, looking toward the development of an information retrieval system with both input and output in natural language organization of large files with emphasis on self-organizing capabilities; engineering terminology for use in indexing; studies of various models of information retrieval systems for the purpose of constructing a general theory of information retrieval; investigation of and experimentation with models for document retrieval systems.

b. Rome Air Development Center: automatic abstracting of English-language text; criteria for manually prepared informative abstracts; graphic format data handling techniques; information technology (development of special-purpose equipment).

c. Air Force Office of Scientific Research: deep indexing techniques; mechanized indexing; nonarithmetic processing systems; theory of information retrieval; semantic analysis; mathematical formulation and computer simulation of documentation methods and systems.

d. Office of Naval Research: basic principles of information retrieval; multi-list processing principles and techniques; mechanized

indexing; computer application to content analysis; structure of the spoken language.

e. National Institutes of Health: use of computers and development of methodology useful in handling medical data and literature; citation indexing; analysis of medical terms and concepts.

4. Tests and Evaluation of New Techniques

This area of activity is developing rapidly in response to the increasing need for more experimentation with existing, and new, information-handling techniques. These new techniques must be evaluated objectively so that their strengths and weaknesses will be made known, and, to accomplish this, valid standards, criteria, and test methods must be developed. The following projects represent current NSF support or the results of NSF projects in this area: a comparative study of the efficiency of four indexing systems by the British Association of Special Libraries and Information Bureaux has resulted in a test method that has been and is being applied to a variety of operating information systems; this same research group (ASLIB) is now engaged in a more refined assessment under controlled conditions of a variety of techniques used in indexing systems; an analytical study by NAS-NRC of the various kinds of chemical notation systems used in systems for searching chemical information is nearing completion; a test environment for the comparison of several techniques for matching research papers in physics to the interests of a sample population of physicists has been designed and will be set up at MIT; two exploratory studies of evaluative criteria have been made; and a variety of tests of a partially mechanized information searching system for metallurgy have been made.

Citation Indexing— Of the newer approaches to the indexing of scientific documents, the Weinberg Panel was particularly impressed with the citation index as a promising bibliographic tool. In order to learn more about this approach, the National Science Foundation is currently sponsoring the compilation and publication of extensive citation indexes for the field of genetics and also for statistics and probability; and is supporting two kinds of experiments to evaluate different techniques for using citation data in indexes and searching systems in the field of physics. A working conference of investigators in this area was held in April 1963, and discussion with social scientists has begun to determine their interest in adapting the technique to research papers in the social sciences.

5. Mechanical Translation Research

In the interest of greater coordination of research in mechanical translation, representatives of the National Science Foundation, the Department of Defense, and the Central Intelligence Agency reached agreement in July 1962 on a "Joint Research and Development Program for Automatic Language Processing" providing for coordination and joint planning in order to insure the most effective use of Federal funds in supporting such research and to increase the ability of these agencies to evaluate the state of the art in terms of their requirements. On the operating level, the Interagency Committee on Mechanical Translation Research set up by the National Science Foundation meets regularly to exchange information on current projects and plans.

Among the measures agreed upon by the three Federal agencies concerned with research on automatic language processing, was the establishment of several types of centers in support of research in this field. One center is to be concerned with the collection and provision of machine-readable texts for use in research. Another type of center will collect, integrate, and process dictionary information for the benefit of the various research projects in the field of mechanical translation. It is expected that eventually this center will be instrumental in making available, as a by-product of the mechanical translation research effort, dictionary information in a variety of languages that will supplement existing technical dictionaries and glossaries.

In U. S. basic research in this field, considerable progress was made this past year in fundamental studies of language processing including the design of computer programs to aid in language analysis, the compilation of bilingual computer dictionary programs, and the development of computer programs for steps in the translation process. The Federal agencies supporting this research include the National Science Foundation, the Departments of the Air Force, the Army and the Navy, and the Central Intelligence Agency.

C. EDUCATION AND TRAINING OF SCIENCE INFORMATION PERSONNEL

As noted by the Weinberg Panel, the education and training of science information personnel is recognized as an important requirement in the search for solutions of the problems of

managing, controlling and disseminating information generated by research and development activities. Beginning in 1961, the National Science Foundation has engaged in the development of an effective, realistic plan of encouragement and support of training programs in this field. The Foundation has in recent months begun to consider proposals related to the training of information specialists. These specialists may be considered to range from the science librarian through the technical literature analyst to the information scientist. Among the types of activities that are considered for support are the following: summer institutes for information specialists, conferences to examine the problems of training science librarians and other specialists, preparation of career booklets on opportunities for employment in the information field, workshops for the development of courses and curricula in the information field, development of programs for training science students in the effective use of scientific literature, and development of interdisciplinary programs for the training of information specialists. A number of proposals for the development of training programs have been received by the Foundation within the past year and it is likely that grants for some pilot projects will be made in the near future.

In addition to the development of training programs by the Foundation, other Federal agencies including the National Institutes of Health, and the Atomic Energy Commission have taken initial steps to provide internships, fellowships, and other cooperative programs aimed at training science information specialists.

Several agencies maintain continuing orientation and training programs for improving the servicing and utilization of scientific information which they generate. Among the agencies which have recently conducted workshops or conferences directed toward this end have been AEC, DOD (DDC), Commerce (OTS), and NASA. Beginning in November 1962, NASA has been holding a series of regional technical information workshops and training seminars directed toward more effective utilization of scientific information which the Agency generates. These sessions emphasize NASA's capability for providing informational tools of direct assistance to the working aerospace scientist and engineer. In the biomedical field, the Public Health Service is accelerating in-service training for information specialists and publications officers, to keep them fully aware of new techniques of communication to the many audiences with whom they deal.

D. INFORMATION FOR INDUSTRY AND THE CIVILIAN ECONOMY

The nation's resources of scientific and technical information have the potential of being much more effectively used by industry and other sectors of the civilian economy, especially in the application of defense and space research results to non-defense activities. To date, difficulties have been experienced by business in (1) realizing that pertinent scientific and technical information on their problems and opportunities may exist, (2) knowing what particular information is available, and (3) ascertaining where information may be secured. All of these difficulties are being studied and acted upon by various Government agencies. Agencies which have newly developed or expanded information programs, specifically directed toward industry, include the following:

1. Office of Technical Services, Department of Commerce

The Office of Technical Services is engaged in a series of studies to make its services more useful to the business community. Local business groups are being visited to learn their interests in technology, and cooperation with trade associations is being examined. With National Science Foundation funding, a survey of information needs of the textile industry is being undertaken by OTS. This survey will seek to determine what scientific and technical information is desirable and useful for dissemination to the textile industry, the current sources of technical information, and ways in which textile information services may be improved with a view to enhancing the technical and economic position of the textile industry of the United States. If this survey proves to be beneficial,

it could be a precursor of surveys for other industries.

2. National Aeronautics and Space Administration

First steps have been taken by NASA to improve the dissemination to the civilian economy of technical information produced during the course of its aerospace research. Selected innovation data submitted by NASA Centers are now being organized for release in the spring of 1963. Subsequent publications will be addressed to many levels of the industrial community and will range from comprehensive state-of-the-art summaries to basic shop notes.

The publication program includes concise write-ups—Flash Sheets—of innovations culled from the entire NASA field center-contractor complex; special reports and monographs which describe specific techniques and processes in detail, including a series entitled "Application Notes." Abstracts of patents in process, pending, or completed will be prepared and circulated; bibliographies and the results of literature searches of concern to the applications program will be similarly published.

3. National Bureau of Standards

To encourage prompt introduction into the measurement efforts of industry and Government of the latest information on standards and measurement methods, the NBS is planning to offer intensive training and educational courses for technical supervisors of standards and measurements laboratories, practicing engineers, and university faculty and graduate students, and others concerned with, or responsible for, measurements.